



STScI | SPACE TELESCOPE
SCIENCE INSTITUTE

EXPANDING THE FRONTIERS OF SPACE
ASTRONOMY

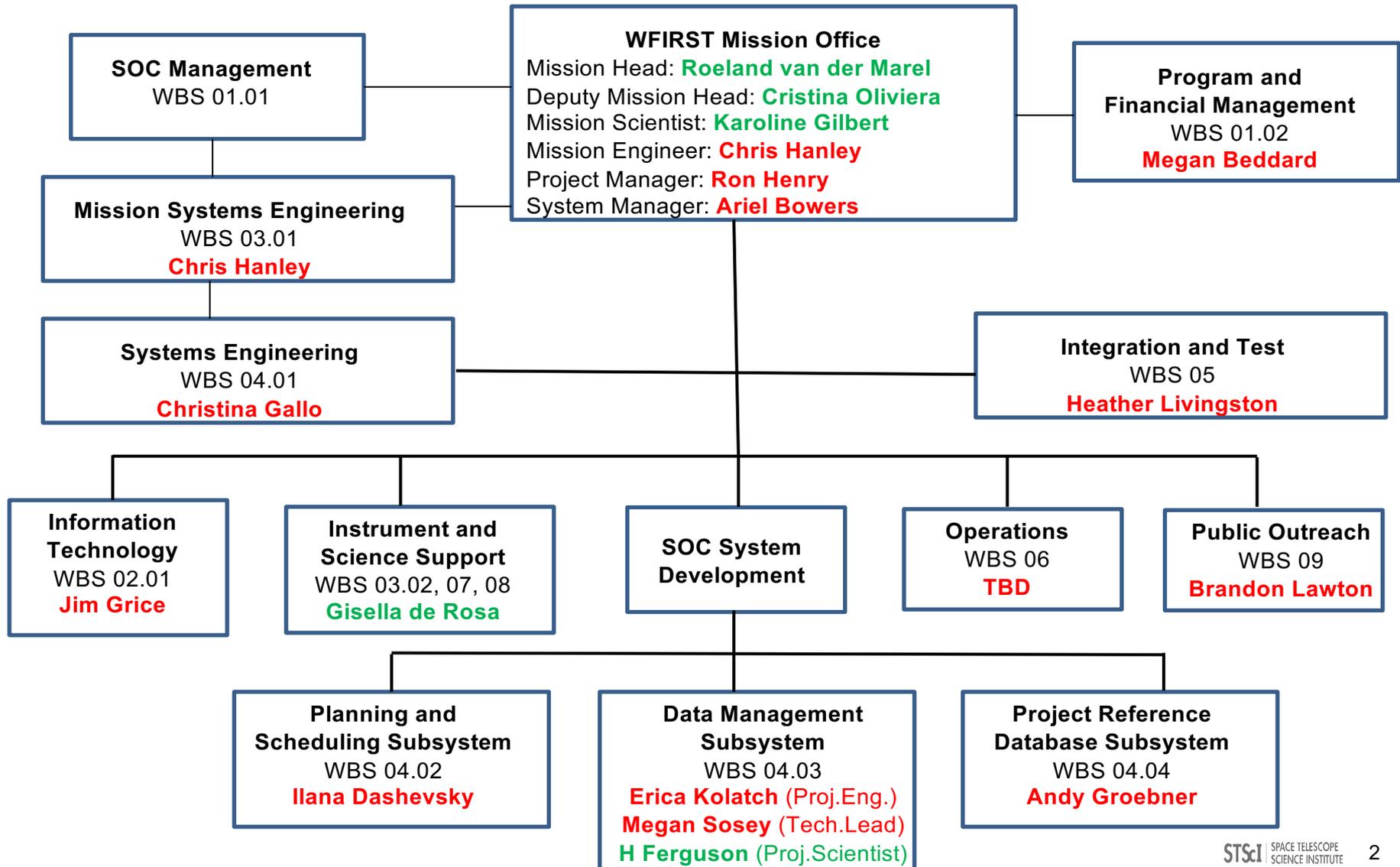
Nancy Grace Roman Space Telescope Science Operations Center (SOC)

Roeland van der Marel

December 11, 2020



SOC Organization



SOC Responsibilities & Design



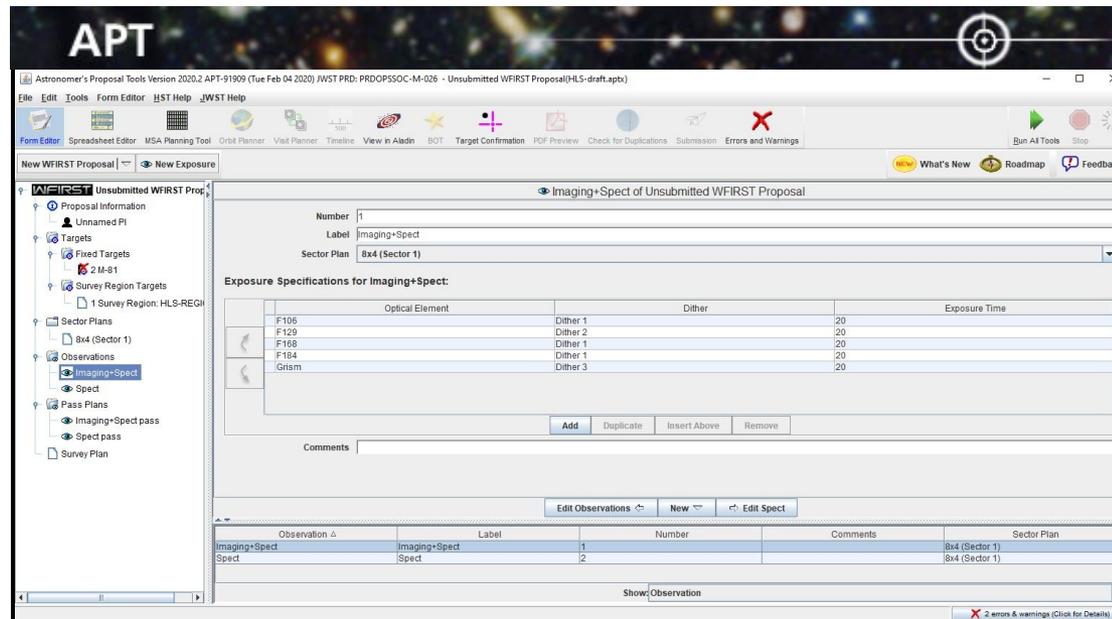
- STScI provides the SOC within the distributed Ground System Architecture
 - Planning & Scheduling (all mission observations) → **Planning & Scheduling System (PSS)**
 - Data Processing for WFI Instrument (details depending on mode) → **Data Management System (DMS)**
 - Most imaging: to Level 4
 - Microlensing Survey: to Level 3
 - Slitless Spectroscopy: to Level 2
 - Archive (all mission observations) → **Data Management System (DMS)**
 - Community Interface for WFI imaging (excl. spectroscopy, microlensing)
 - User support, documentation, community engagement, public outreach
- Systems are in Critical Design and include
 - New concepts/development in unique Roman areas
 - Reuse/adaptation/leveraging from other missions when possible (Hubble, Webb, Kepler/TESS, MAST, Rubin, etc.)
 - Leveraging Science Team contributions (e.g., algorithms & data products)



Planning and Scheduling System



- Adaptation from HST/JWST of the “Astronomer’s Proposal Tool” (APT) for WFI observation definition, and other sophisticated planning and scheduling system components with long heritage



Roman APT Example: WFI/HLS with imaging+spectroscopy

- Ongoing design trades address complexities unique to Roman, e.g.:
 - What is the appropriate schedulable unit (orbits, visits, tiles, ...)
 - Interfaces with the GSFC Mission Operations Center (spacecraft commanding scripts)
 - Interfaces with the IPAC Science Support Center (GO proposal and CGI program tools)

Data Management System



- Roman is the first NASA Astrophysics “Big Data” survey mission
 - Both catalogs and pixel-level data sets provide unique science opportunities
 - The capabilities required to download or process the very large Roman datasets will exceed what average users can do with standard resources
- Data products will be generated by multiple mission partners
 - Calibrated and mosaiced images, extracted spectra, catalogs, etc.
 - Staged in the cloud and co-located with significant computational resources
 - Open source and modular imaging pipeline (facilitating custom reprocessing)
- The STScI MAST Archive will be the key to Roman Science
 - Most NASA Great Observatory science is already (part) Archival
 - Accessibility & Diversity: 2-4x increase in institutions publishing
- WFI Data Management Environment
 - Cloud-based science platform for high-level data processing
 - Jupyter Lab environments and notebooks to ease access
 - Capability to bring software to Roman’s Big Data, and enable sharing of software by science centers, science teams, and community
 - Users should plan to interact in new ways with such big data sets
- Details of all this are part of ongoing design trades

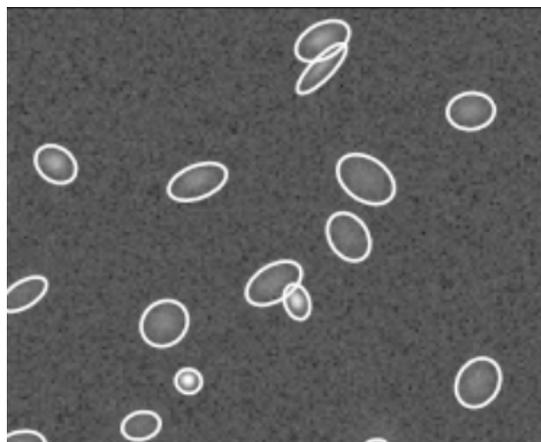




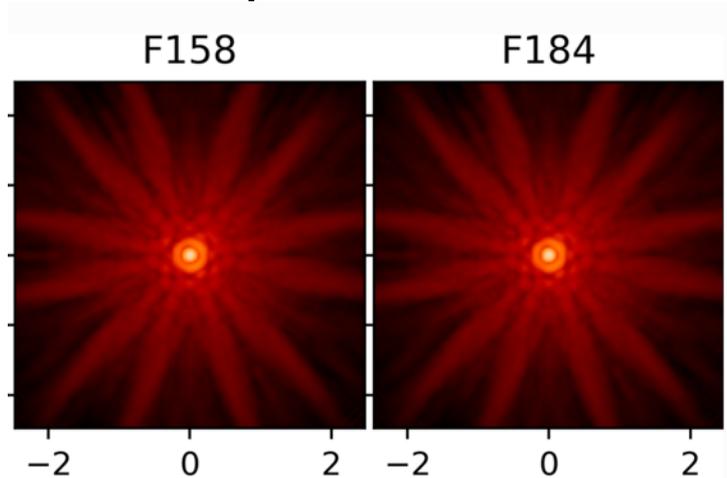
WFIRST Imaging High-Level Pipeline Components



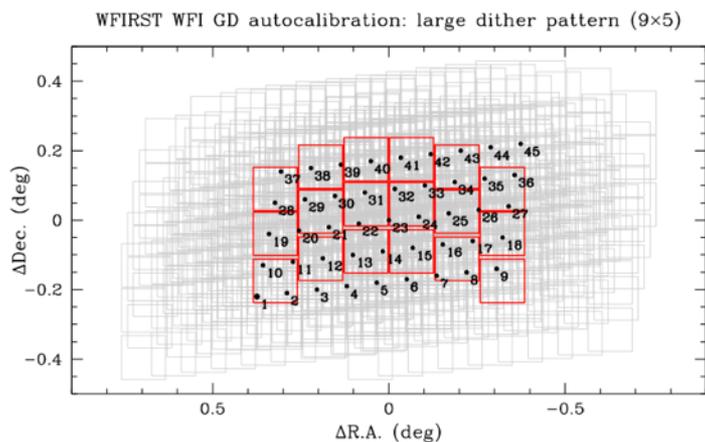
Catalogs



Point spread functions



Astrometry

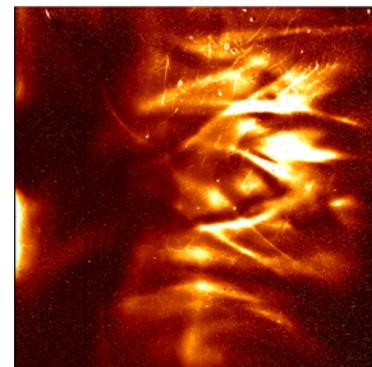


Simulations

Astronomical Sources



Instrument signatures



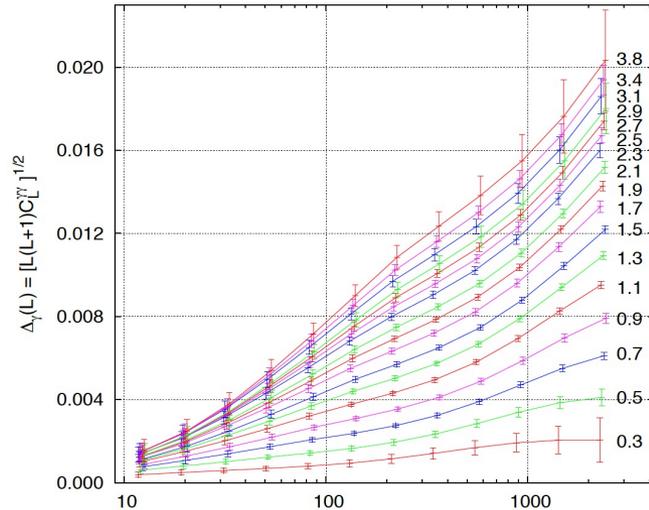
→ Completeness/Systematics



WFI/Imaging Calibration Planning



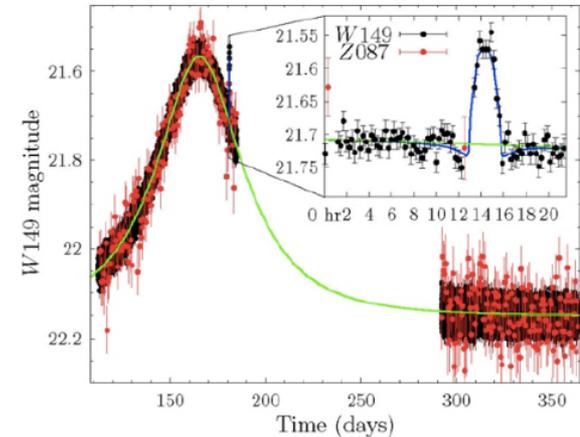
0.05% PSF shape (impacts cosmic shear)



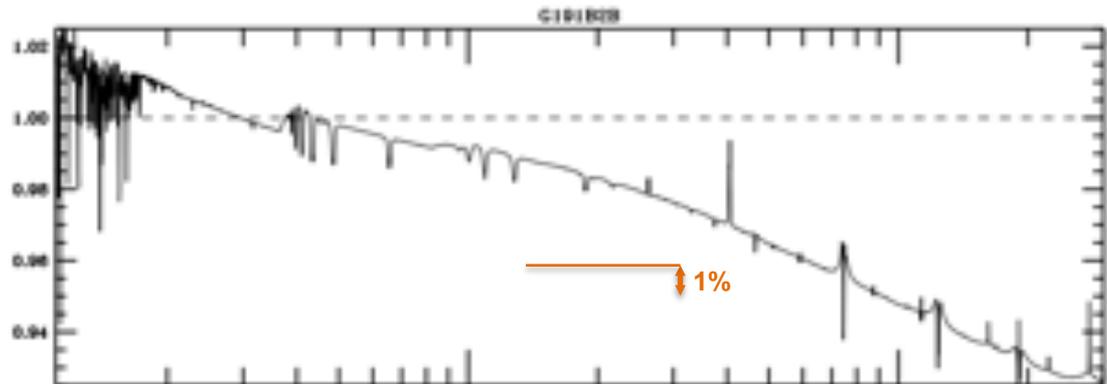
Expected shear power spectrum^L
(SDT report, Spergel+ 2015)

- Required accuracies up to ~10x better than what is available on other missions (e.g., Hubble)

0.1% Photometric stability for microlensing (maps to planet mass uncertainty)



Simulated microlensing event (S. Carey)

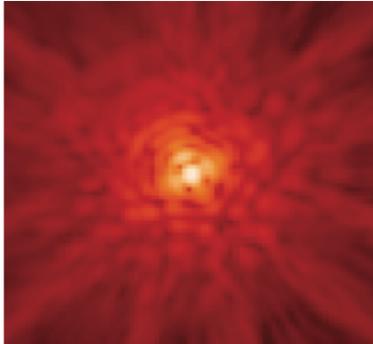


Ratio between white dwarf spectral models (Bohlin+ 2014)

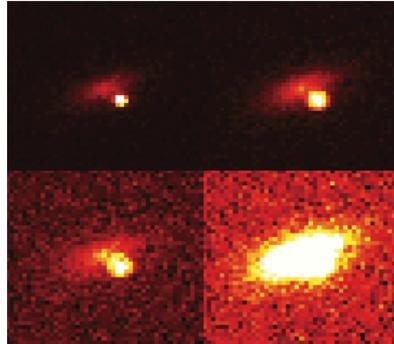
0.5% ABSOLUTE color calibration for SNe (maps to luminosity distance vs redshift)

Simulation Tools & Applications

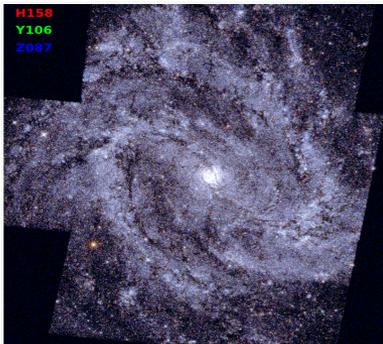
<https://www.stsci.edu/roman/science-planning-toolbox>



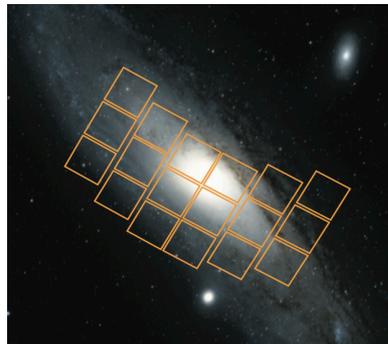
WebbPSF
Wavelength
Dependent
PSF Simulator



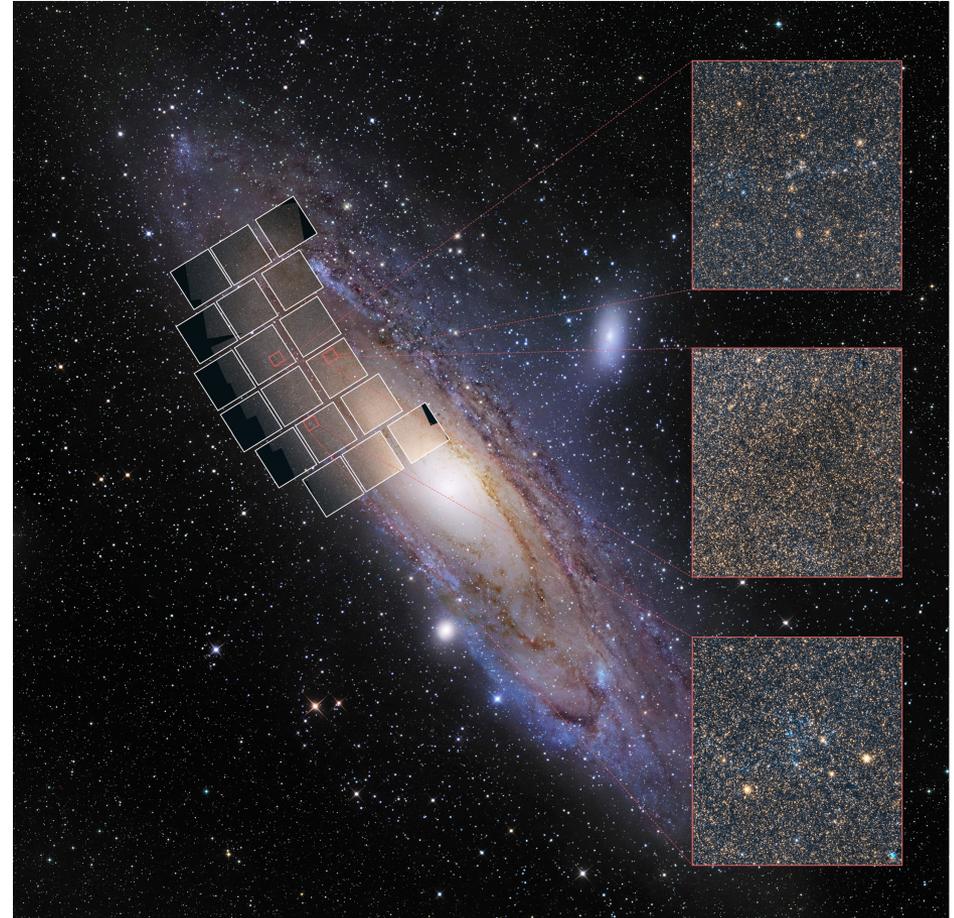
Pandeia
3-D (x,y,λ) Exposure
Time Calculator and
Image simulator



STIPS
Image Simulator



FOV Overlay



Simulated Roman Observation of M31
(B. Williams with aid of STIPS)

Complementary to tools developed by the community and other partners



Working Groups, User Support, Documentation, etc.



- SOC Scientists perform a range of activities
 - (co-)chair project-wide Working Groups with FSWG/SIT/partner scientists on a range of scientific and technical topics
 - Organize Hack Days, Focus Meetings, Jamborees, etc.
 - User support of Science Teams (or are themselves co-investigators)
 - Produce white papers and documentation to inform the community about the scientific opportunities provided by Roman

Solar system science with the Wide-Field Infrared Survey Telescope

Bryan J. Holler et al.

Astrometry with the Wide-Field Infrared Space Telescope

The WFIRST Astrometry Working Group:

Etc, etc, etc.....

WFIRST coronagraphic operations: lessons learned from the Hubble Space Telescope and the James Webb Space Telescope

John H. Debes et al.

An Ultra Deep Field survey with WFIRST

Anton M. Koekemoer (STScI), R. J. Foley (UCSC), D. N. Spergel (Princeton/CCA), M. Bagley (UT Austin), R. Bezanson (Pittsburgh), F. B. Bianco (NYU), R. Bouwens (Leiden), L. Bradley (STScI), G. Brammer (NBI), P. Capak (Caltech), I. Davidzon (Caltech), G. De Rosa (STScI), M. E. Dickinson (NOAO), O. Doré (JPL), J. S. Dunlop (ROE), R. S. Ellis (UCL), X. Fan (Arizona), G. G. Fazio (CfA), H.

arXiv.org > astro-ph > arXiv:1907.07184

ASTRO 2020

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On the need for synthetic data and robust data simulators in the 2020s

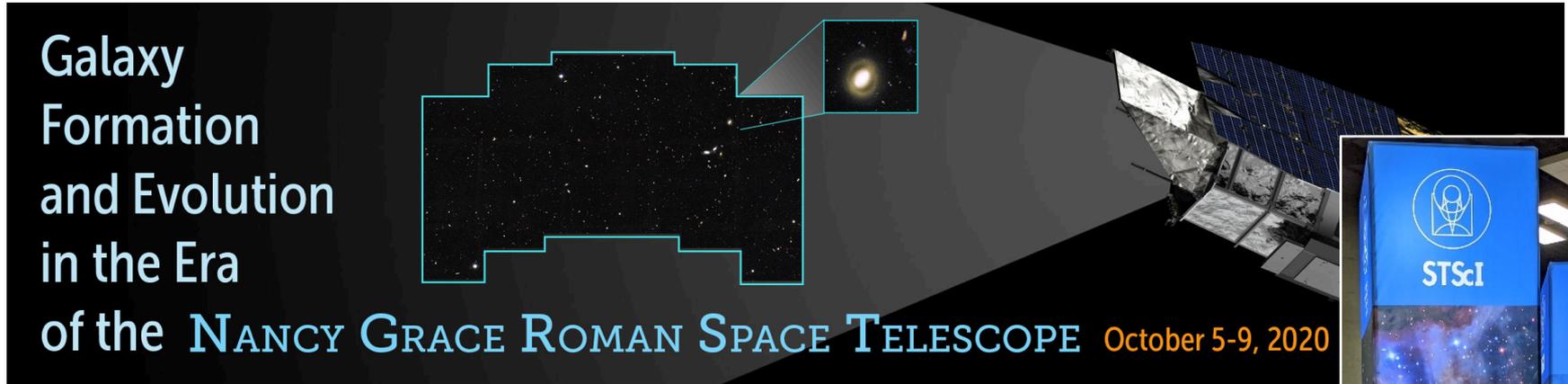
Molly S. Peeples (STScI/JHU), Bjorn Emonts (NRAO), Mark Kyprianou (STScI), Matthew T. Penny (Ohio State), Gregory F. Snyder (STScI), Christopher C. Stark (STScI), Michael Troxel (Duke), Neil T. Zimmerman (GSFC), John ZuHone (Harvard-Smithsonian CfA)



Community Engagement



- Regular Science Conferences to engage the astronomical community. Example: [recent virtual meeting](#) (~300 attendees)



- Website (<http://www.stsci.edu/roman>) for dissemination of observatory and instrument information, science plans and opportunities, operational planning, data simulation tools, documentation, news and events, etc.
- Provide collaboration spaces via Outerspace for Project, Science Team, and advisory committees
- Regular STScI Newsletter articles
- Support/demos/splinters/townhalls at AAS and other professional meetings
- Handouts and print products about the observatory & science



STScI Roman staff answer questions at the STScI AAS booth.

Highlight the wide range of astrophysical subject areas that Roman will revolutionize

Evolution of the Universe



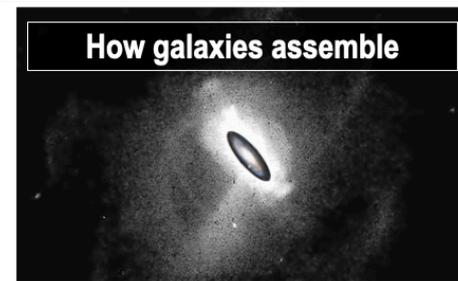
Universe of galaxies



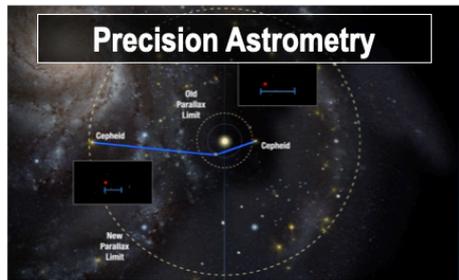
Mapping dark matter



How galaxies assemble



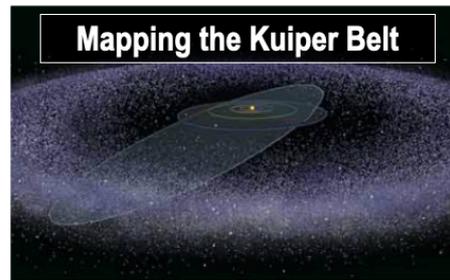
Precision Astrometry



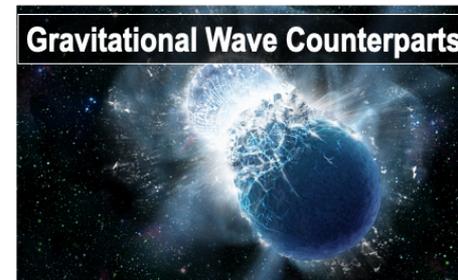
Resolved Stellar Populations



Mapping the Kuiper Belt



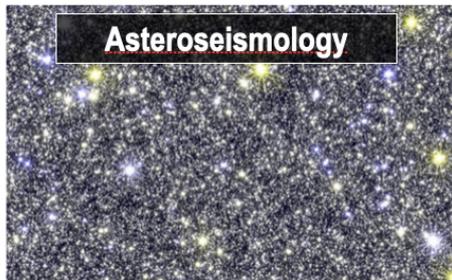
Gravitational Wave Counterparts



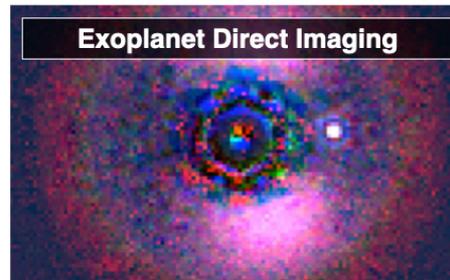
Stellar Nurseries



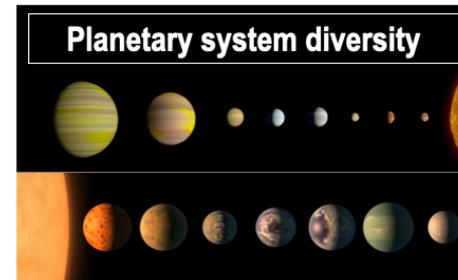
Asteroseismology



Exoplanet Direct Imaging



Planetary system diversity

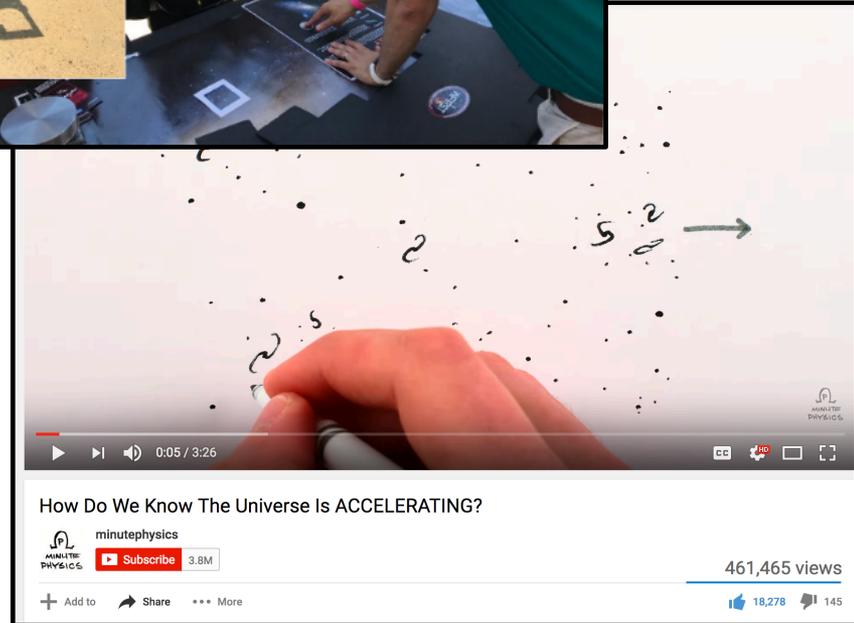


- Recent questionnaire highlights community interests in using Roman (data) extend well beyond cosmology and exoplanet science

Public Outreach



Roman field-of-view activity, used for the Apollo 50th Celebration on the National Mall and the AAS Student Outreach activity



Roman viewable in 3D using [STScI STAR Augmented Reality App](#)

YouTube MinutePhysics Video (>0.5M views)
“How Do We Know the Universe is Accelerating?”
<https://www.youtube.com/watch?v=tXkBfkeJJ5c>



Roman Field of View
Ground-based image